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(54) **METHOD OF MANUFACTURING DISPLAY APPARATUS**

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(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**

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G06F 3/041	(2006.01)
H01L 51/56	(2006.01)
H01L 27/32	(2006.01)
G02F 1/1333	(2006.01)
H01L 51/52	(2006.01)

(52) **U.S. Cl.**

CPC ***G06F 3/0412*** (2013.01); ***H01L 27/323*** (2013.01); ***H01L 51/56*** (2013.01); *G02F 1/13338* (2013.01); *G02F 2201/50* (2013.01); *G02F 2201/501* (2013.01); *G06F 2203/04103* (2013.01); *H01L 51/5256* (2013.01); *Y10T 29/49002* (2015.01)

(58) **Field of Classification Search**

CPC G02F 1/13338; G02F 2201/50; G02F 2201/501; G06F 2203/04103; G06F 3/041; G06F 3/0412; G06F 3/147; H01L 27/323; H01L 51/5256; H01L 51/56; Y10T 29/49002; Y10T 29/49117; Y10T 29/49128

USPC 29/592.1, 602.1, 831, 835, 846, 854, 29/871, 872, 873; 178/18.01, 18.03, 178/18.05; 345/173, 174; 349/149–152

See application file for complete search history.

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(57) **ABSTRACT**

A method of manufacturing a display apparatus includes providing a display panel including two substrates facing each other and a display device disposed between the two substrates; providing a touch screen panel attached onto an outer side surface of one of the two substrates; attaching a multilayer protection film including a plurality of films having acid resistance onto the touch screen panel; etching the other of the two substrates; and removing the multilayer protection film. The protection films have penetration holes, each of the protection films having a different average area of the penetration holes in a plan view.

12 Claims, 4 Drawing Sheets

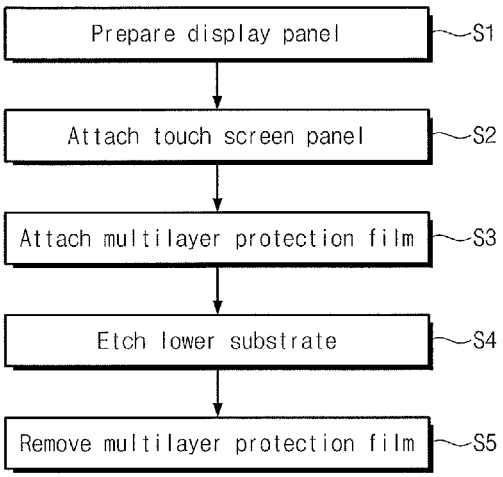


Fig. 1

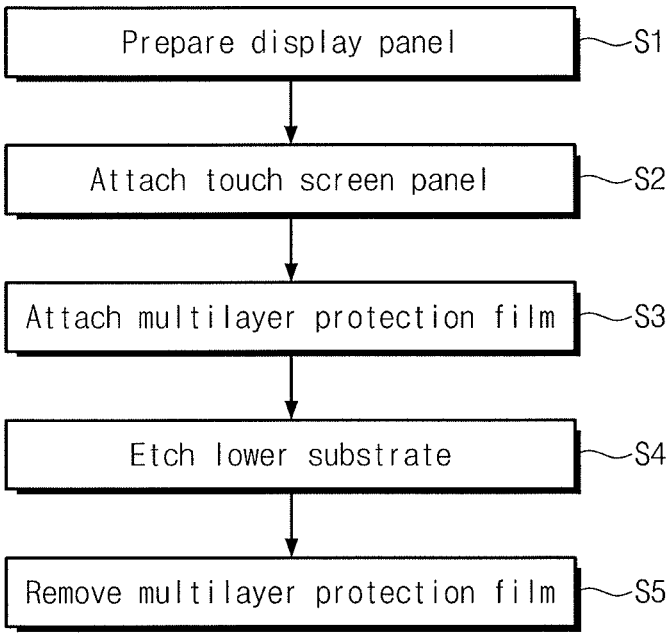

Prepare display panel
S1
Attach touch screen panel
S2
Attach multilayer protection film
S3
Etch lower substrate
S4
Remove multilayer protection film
S5

Fig. 2A

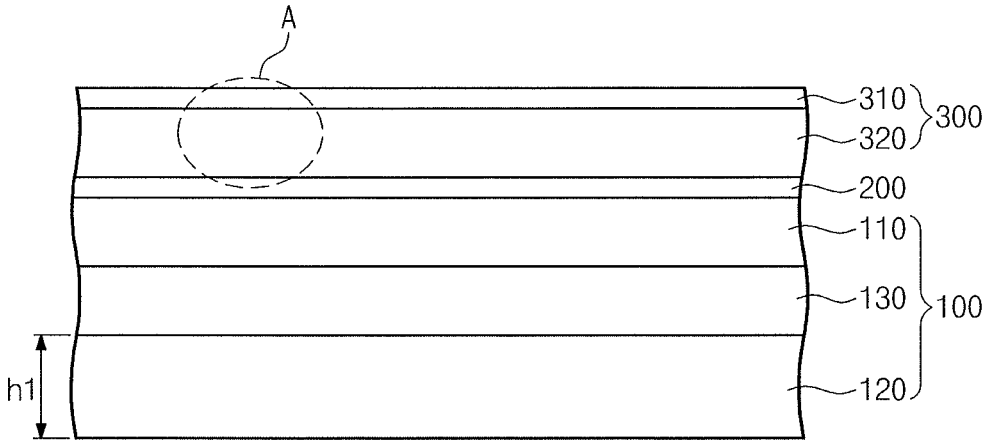


Fig. 2B

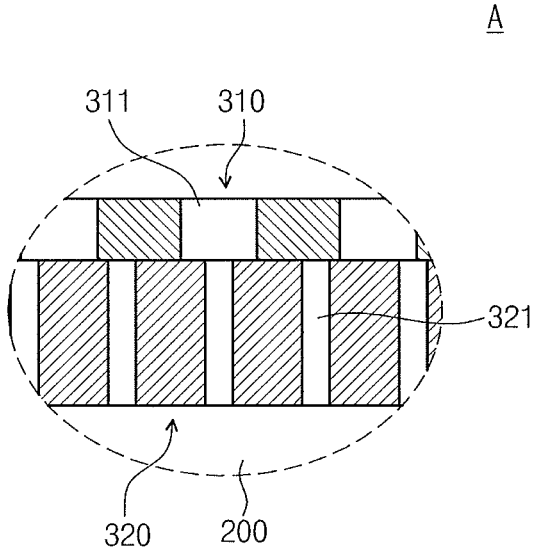


Fig. 3

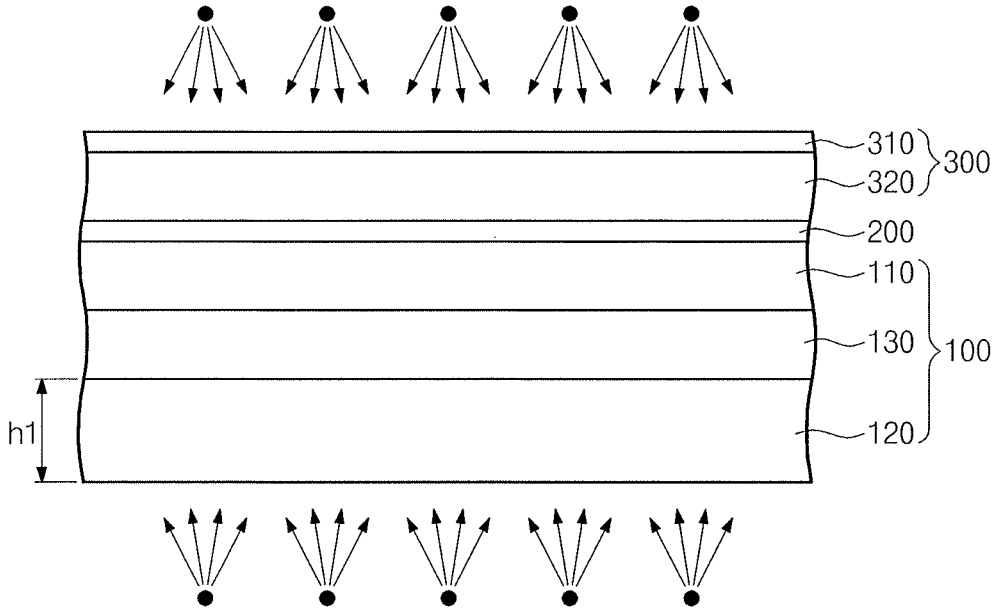


Fig. 4

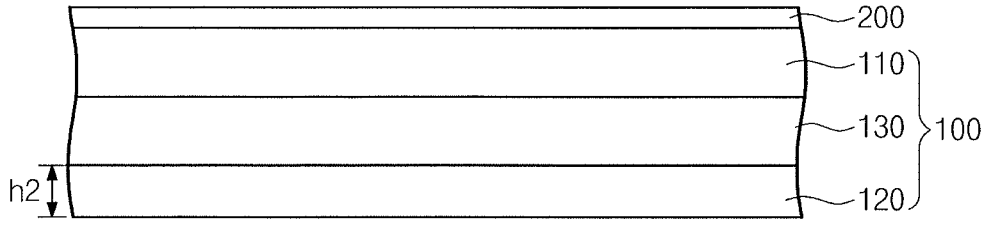


Fig. 5A

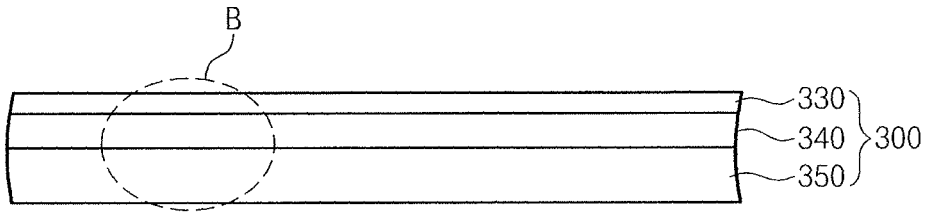
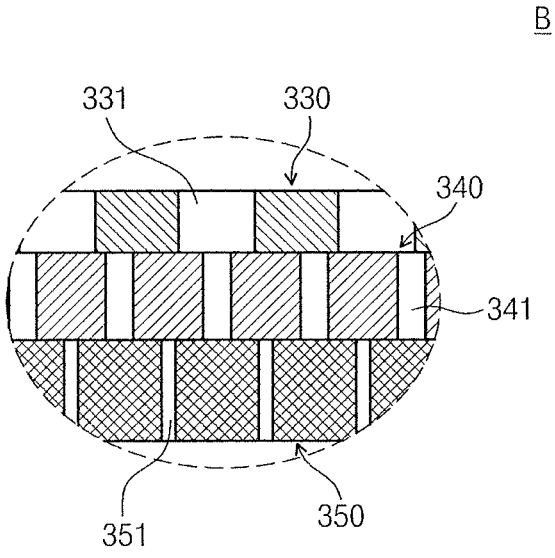


Fig. 5B



METHOD OF MANUFACTURING DISPLAY APPARATUS

CROSS-REFERENCE TO RELATED APPLICATION

This U.S. non-provisional patent application claims priority under 35 U.S.C. §119 to Korean Patent Application No. 10-2012-0129028, filed on Nov. 14, 2012, and entitled: "METHOD OF MANUFACTURING DISPLAY APPARATUS," the entire contents of which are herein incorporated by reference in their entirety.

BACKGROUND

1. Field

Embodiments relate to a method of manufacturing a display apparatus.

2. Description of the Related Art

A display apparatus may include a display device, an upper substrate disposed on the display device, and a lower substrate facing the upper substrate while supporting the display device.

The display device emits an outputted image and is disposed between the upper and lower substrates. The display device, the upper substrate, and the lower substrate are called a display panel. The upper substrate is disposed on the display device and performs a function of protecting the display device. The upper substrate may include a touch screen panel. The lower substrate faces the upper substrate while supporting the display device.

SUMMARY

Embodiments are directed to a method of manufacturing a display apparatus, including providing a display panel including two substrates facing each other and a display device disposed between the two substrates, providing a touch screen panel attached onto an outer side surface of one of the two substrates, attaching a multilayer protection film including a plurality of protection films having acid resistance onto the touch screen panel, etching the other of the two substrates, and removing the multilayer protection film. The protection films have penetration holes, each of the protection films having a different average area of the penetration holes in a plan view.

The average area of the penetration holes of respective ones of the protection films in a plan view may increase in accordance with a distance of the respective ones of the protection films from the touch screen panel.

A thickness of each of the protection films may decrease in accordance with an increase in the average areas of the penetration holes of the protection films.

The etching process may include a wet etching process using an etchant.

The average area of penetration holes of each of the protection films may be equal to or smaller than a size of molecules in the etchant.

The multilayer protection film may include a first protection film disposed on the touch screen panel and exposed to the outside when the etching process is performed, and a second protection film disposed between the first protection film and the touch screen panel.

The average area of penetration holes of the first protection film may be greater than the average area of penetration holes of the second protection film in a plan view.

A thickness of the second protection film may be greater than a thickness of the first protection film.

The multilayer protection film may include a first protection film disposed on the touch screen panel and exposed to the outside when the etching process is performed, a second protection film disposed between the first protection film and the touch screen panel, and a third protection film disposed between the second protection film and the touch screen panel.

An average area of penetration holes of the first protection film may be greater than an average area of penetration holes of the second protection film. The average area of penetration holes of the second protection film may be greater than an average area of penetration holes of the third protection film.

A thickness of the third protection film may be greater than a thickness of the second protection film. The thickness of the second protection film may be greater than a thickness of the first protection film.

BRIEF DESCRIPTION OF THE FIGURES

Features will become apparent to those of ordinary skill in the art by describing in detail exemplary embodiments with reference to the attached drawings in which:

FIG. **1** is a flow chart illustrating a method of manufacturing a display apparatus in accordance with one embodiment.

FIGS. **2**A, **3**, and **4** are process cross sectional views illustrating stages of a method of manufacturing a display apparatus in accordance with one embodiment.

FIG. **2**B is an enlarged view of area A illustrated in FIG. **2**A.

FIG. **5**A is a cross sectional view of a multilayer protection film used in a method of manufacturing a display apparatus in accordance with another embodiment.

FIG. **5**B is an enlarged view of area B illustrated in FIG. **5**A.

DETAILED DESCRIPTION

Embodiments will be described more fully hereinafter with reference to the accompanying drawings, in which embodiments are shown. However, these may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope thereof to those skilled in the art. In the drawings, the size and relative sizes of layers and regions may be exaggerated for clarity. Like numbers refer to like elements throughout.

The meaning of 'comprise', 'include', or 'have' specifies a property, a region, a fixed number, a step, a process, an element, and/or a component but does not exclude other properties, regions, fixed numbers, steps, processes, elements, and/or components. In the specification, it will be understood that when a layer (or film), a region, or a plate is referred to as being 'on' another layer, region, or plate, it can be directly on the other layer, region, or plate, or intervening layers, regions, or plates may also be present. In the specification, it will be understood that when a layer (or film), a region, or a plate is referred to as being 'under' another layer, region, or plate, it can be directly under the other layer, region, or plate, or intervening layers, regions, or plates may also be present.

FIG. **1** is a flow chart illustrating stages of method of manufacturing a display apparatus in accordance with one embodiment. FIGS. **2**A, **3**, and **4** are process cross sectional views illustrating the stages of the method of manufacturing

a display apparatus in accordance with the embodiment. FIG. **2**B is an enlarged view of area A illustrated in FIG. **2**A.

Referring to FIG. **1**, the method of manufacturing a display apparatus in accordance with one embodiment includes preparing or providing a display panel (S**1**), attaching a touch screen panel (S**2**), attaching a multilayer protection film (S**3**), etching a lower substrate (S**4**), and removing the multilayer protection film (S**5**).

The method of manufacturing a display apparatus will be described in detail with reference to FIGS. **2**A, **2**B, **3**, and **4**.

First, in preparing or providing the display panel S**1**, a display panel **100** that can display an image is manufactured or obtained.

A spontaneous emission display panel such as an organic light emitting display panel may be used as the display panel **100**. A non-emissive display panel such as a liquid crystal display panel, an electrowetting display panel, an electrophoretic display panel, or a microelectromechanical system display panel may be used as the display panel **100**. In the present embodiment, the organic light emitting display panel is described as an illustration.

The organic light emitting display panel is a self-emission display panel.

Accordingly a viewing angle and contrast may be superior as compared with the liquid crystal display panel. Also, the organic light emitting display panel does not need a backlight. Accordingly, the organic light emitting display panel may be lightweight and thin, and may be advantageous with respect to power consumption, as compared with the liquid crystal display panel.

The organic light emitting display panel has a structure that an organic light emitting device **130** is disposed between two substrates **110** and **120** facing each other.

The organic light emitting display panel includes the organic light emitting device **130** disposed on a lower substrate **120**, and an upper substrate **110** bonded to the lower substrate **120** by a sealing material (not shown) while protecting the organic light emitting device **130**. The lower substrate **120** includes a thin film transistor array (not shown).

The organic light emitting device **130** includes an anode electrode (not shown), an organic film (not shown), and a cathode electrode (not shown) which are stacked on the lower substrate **120** in order. The organic film may include a hole injection layer (HIL) injecting a hole, a hole transport layer (HTL) which smoothly transports the hole and suppresses the movement of electrons that are not combined in a light emitting layer EML to increase a recombination chance of the hole and the electron, the light emitting layer EML emitting light by recombination of the electron and the hole that are injected, a hole blocking layer (HBL) for blocking the movement of holes that are not combined in the light emitting layer EML, an electron transport layer (ETL) for smoothly transporting the electron to the light emitting layer EML, and an electron injection layer (EIL) injecting the electron.

A direction from the lower substrate **120** toward the upper substrate **110** may be referred to as a front side direction and a direction from the upper substrate **110** toward the lower substrate **120** may be referred to as a back side direction. If the display panel **100** is a front side light emitting type that light generated from the organic film is output in the front side direction, the cathode electrode may have a semitransparent property and the anode electrode may have a light reflection property. If the display panel **100** is a back side light emitting type that light generated from the organic film is output in the back side direction, the cathode electrode may have a light reflection property and the anode electrode may have a semitransparent property.

In attaching a touch screen panel **200** (S**2**), the touch screen panel **200** is attached onto an outer side surface of one of the two substrates of the display panel **100**. For instance, the touch screen panel **200** may be attached onto the upper substrate **110**.

The touch screen panel **200** is an apparatus of inputting information by touching the screen panel with a finger or a pen. Examples of the touch screen panel **200** include a resistive method, a capacitive method, and an infrared method according to methods of sensing touch event of the touch screen panel **200**.

The resistive method drives the screen panel using a touch being generated between electrodes by putting pressure on the screen panel. The capacitive method drives the screen panel using a change of capacitance being generated by touching the screen panel with a finger.

The touch screen panel **200** may be attached onto the upper substrate **110** using an optically clear adhesive.

In attaching a multilayer protection film **300** (S**3**), as illustrated in FIG. **2**A, a multilayer protection film **300** including a plurality of protection films **310** and **320** having acid resistance is attached on the touch screen panel **200**.

The multilayer protection film **300** is attached onto an entire surface of the upper substrate **110** including the touch screen panel **200**.

As illustrated in FIG. **2**B, the multilayer protection film **300** includes a first protection film **310** and a second protection film **320**. The first protection film **310** is disposed on the touch screen panel **200** and is exposed to the outside when an etching process which will be discussed below is performed. The second protection film **320** is disposed between the first protection film **310** and the touch screen panel **200**. That is, the second protection film **320** is attached onto the touch screen panel **200**.

The first protection film **310** and the second protection film **320** may be formed of an acid resistance material (e.g., an organic highly polymerized film) that does not react to an etchant, as will be described below. As the organic highly polymerized film, a polyolefin polymer, for example, polyethylene, polypropylene, polybutadiene, polyvinyl chloride, polystyrene, or a copolymer including them may be used.

The first protection film **310** includes a plurality of penetration holes **311**, and the second protection film **320** includes a plurality of penetration holes **312**. In a plan view, average areas of the penetration holes **311** and **321** are different from each other with respect to the first protection film **310** and the second protection film **320**. It is desirable that the average area of the penetration holes **321** of the second protection film **320** be smaller than the average area of the penetration holes **311** of the first protection film **310** in a plan view. That is, in a plan view, an average area of each of the penetration holes **311** and **321** of the protection films **310** and **320** increases with in accordance with the distance of the respective protection film **310** or **320** from the touch screen panel **200**.

Also, it is desirable that thicknesses of the first and second protection films **310** and **320** be different from each other. For instance, a thickness of the first protection film **310** may be smaller than a thickness of the second protection film **320**.

In a plan view, the average area of the penetration holes **321** of the second protection film **320** is smaller than the average area of the penetration holes **311** of the first protection film **310**. A length of each the penetration holes **321** of the second protection film **320** is greater than a length of each the penetration holes **311** of the first protection film **310** when viewed in a longitudinal direction of each penetration holes **321** and **311**. Thus, even though molecules in the etchant may pass

through the first protection film **310**, it may be difficult for the molecules in the etchant to pass through the second protection film **320**.

In etching the lower substrate **120** (S**4**), as illustrated in FIG. **3**, a part of the lower substrate **120** is etched using a wet etching process. Accordingly, as illustrated in FIG. **4**, a thickness of the lower substrate **120** is reduced from a first thickness h**1** to a second thickness h**2**.

As the wet etching process, a dipping method, a spray method, or a top-down glass etching method may be used. For example, the dipping method is a method of etching the lower substrate **120** by vertically dipping the plurality of display panels **100** in a bath. The spray method is a method of etching the lower substrate **120** by spraying an etchant onto both sides of the display panel **100**, which stands vertically at a predetermined spray pressure, using a plurality of spray nozzles. The top-down glass etch method is a method of etching the lower substrate **120** by pouring an etchant onto the display panel **100**, which stands vertically, so that the etchant flows down from an upper portion of the display panel **100**.

The etchant includes hydrofluoric acid or a material of hydrofluoric acid salt system.

When the etching process is performed, to protect a side surface of the display apparatus that is not protected by the multilayer protection film **300**, an additional protection member (not shown) may cover the side surface of the display apparatus.

In removing the multilayer protection film **300** (S**5**), the multilayer protection film **300** attached to the display panel **100** may be removed from the display panel **100** through a cleaning process.

After the multilayer protection film **300** is removed, a window and a housing for protecting an exposed external surface of the display apparatus may be mounted.

As described above, by performing the etching process while attaching the multilayer protection film **300** onto the touch screen panel **200**, the touch screen panel **200** may be protected when the etching process is performed.

FIG. **5**A is a cross sectional view of a multilayer protection film used in a method of manufacturing a display apparatus in accordance with another embodiment. FIG. **5**B is an enlarged view of area B illustrated in FIG. **5**A.

Referring to FIGS. **5**A and **5**B, the multilayer protection film **300** may include a first protection film **330** disposed on the touch screen panel **200** and exposed to the outside when an etching process is performed, a second protection film **340** disposed between the first protection film **330** and the touch screen panel **200**, and a third protection **350** disposed between the touch screen panel **200** and the second protection film **340**.

Referring to FIGS. **5**A and **5**B, respective average areas of penetration holes **331**, **341** and **351** of the first, second and third protection films **330**, **340**, and **350** in a plan view are different from one another. It is desirable that the average areas of each the penetration holes **331**, **341** and **351** increase with in accordance with the distance of the respective protections film **330**, **340**, or **350** from the touch screen panel **200** in a plan view. That is, the average area of the penetration holes **331** of the first protection film **330** may be greater than the average area of the penetration holes **341** of the second protection film **340** and the average area of the penetration holes **341** of the second protection film **340** may be greater than the average area of the penetration holes **351** of the third protection film **350**.

Respective thickness of the first, second, and third protection films **330**, **340**, and **350** may decrease in accordance with the distance from the touch screen panel **200**. Thus, a length of each of the penetration holes **331** of the first protection film **330** is smaller than a length of each of the penetration holes **341** of the second protection film **340**, and the length of each of the penetration holes **341** of the second protection film **340** is smaller than a length of each of the penetration holes **351** of the third protection film **350**.

The molecules in the etchant most easily pass through the penetration holes **331** of the first protection film **330** and the molecules in the etchant may pass through the penetration holes **351** of the third protection film **350** with difficulty. Thus, the multilayer protection film **300** may suppress the penetration of the molecules in the etchant.

By way of summation and review, in a method of manufacturing a display device, in order to obtain light weight of the display apparatus and minimization of thickness of the display apparatus, it may be desirable to reduce a thickness of the upper substrate or the lower substrate.

Accordingly, an etching process may be carried out. In the case that the touch screen panel is further added to the display apparatus, a protection film is attached to protect the touch screen panel mounted on the upper substrate. The protection film is removed after performing the etching process.

However, during the etching process, molecules in an etchant may penetrate into the protection film to damage the touch screen panel.

In contrast, as described above, by performing the etching process while the multilayer protection film described herein is attached to the touch screen panel, the upper panel including the touch screen panel may be protected when the etching process is performed to etch the lower substrate.

According to a method of manufacturing a display apparatus, efficiency of an etching process may be improved and the effect of light weight and minimization may be obtained.

The foregoing is illustrative and is not to be construed as limiting thereof. Although a few embodiments have been described, those skilled in the art will readily appreciate that many modifications are possible in the embodiments without materially departing from the novel teachings and advantages of the present invention. Accordingly, all such modifications are intended to be included within the scope of the present invention as defined in the claims. The present invention is defined by the following claims, with equivalents of the claims to be included therein.

What is claimed is:

1. A method of manufacturing a display apparatus, the method comprising:

providing a display panel including a first substrate and a second substrate facing each other and a display device disposed between the first substrate and the second substrate;

providing a touch screen panel attached onto an outer side surface of the first substrate;

attaching a multilayer protection film including a plurality of protection films having acid resistance onto the touch screen panel;

etching the second substrate; and

removing the multilayer protection film,

wherein the protection films have penetration holes, each of the protection films having a different average area of the penetration holes in a plan view.

2. The method of claim **1**, wherein the average area of the penetration holes of respective ones of the protection films in a plan view increases in accordance with a distance of the respective ones of the protection films from the touch screen panel.

3. The method of claim 2, wherein a thickness of respective ones of the protection films decreases in accordance with an increase in the average area of the penetration holes of the protection films.

4. The method of claim 1, wherein the etching process includes a wet etching process using an etchant.

5. The method of claim 4, wherein the average area of penetration holes of each of the protection films is equal to or smaller than a size of molecules in the etchant.

6. The method of claim 1, wherein the multilayer protection film includes:

a first protection film disposed on the touch screen panel and exposed to the outside when the etching process is performed; and

a second protection film disposed between the first protection film and the touch screen panel.

7. The method of claim 6, wherein the average area of penetration holes of the first protection film is greater than the average area of penetration holes of the second protection film in the plan view.

8. The method of claim 7, wherein a thickness of the second protection film is greater than a thickness of the first protection film.

9. The method of claim 1, wherein the multilayer protection film includes:

a first protection film disposed on the touch screen panel and exposed to the outside when the etching process is performed;

a second protection film disposed between the first protection film and the touch screen panel; and

a third protection film disposed between the second protection film and the touch screen panel.

10. The method of claim 9, wherein:

an average area of penetration holes of the first protection film is greater than an average area of penetration holes of the second protection film, and

the average area of penetration holes of the second protection film is greater than an average area of penetration holes of the third protection film.

11. The method of claim 10, wherein:

a thickness of the third protection film is greater than a thickness of the second protection film and

the thickness of the second protection film is greater than a thickness of the first protection film.

12. The method of claim 1, wherein etching the second substrate reduces a thickness of the second substrate.

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